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EFFECTS OF LINT-CLEANER FEED RATES, SAW-CYLINDER, AND FEED-ROLL SPEEDS ON LINT QUALITY AND BALE VALUE OF SOUTHEASTERN AREA COTTON

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EFFECTS OF LINT-CLEANER FEED RATES, SAW-CYLINDER, AND FEED-ROLL SPEEDS ON LINT QUALITY AND BALE VALUE OF SOUTHEASTERN AREA COTTON

By Richard A. Wesley[1]

SUMMARY

Increases in the lint feed rate to the lint cleaner did not have significant effects on cleaning efficiency, the fiber-length measurements of either the cleaned lint or lint-cleaner waste material, or resulting bale values of 'Coker 201' cotton. However, at increased lint feed rates, the amount of waste material removed by lint cleaning increased. At increased saw-cylinder speeds, there were significant reductions in the foreign-matter content of the cleaned lint, representing an increase in waste material removed by lint cleaning, and increased cleaning efficiency. The increased saw-cylinder speeds reduced the classer's staple length, yet the fiber-length distribution remained unchanged. Effects of feed-roll speed were minor and nonsignificant. Increases in bale value attributed to saw-cylinder and feed-roll speed were nonsignificant.

REVIEW OF LITERATURE

The development of lint-cleaning machinery dates back to 1842 when Theodorick James was granted a lint-cleaning patent. Additional developments were credited to Carver in 1844 and Withers in 1858. The efforts of these pioneers mainly involved either the cleaning of the seed cotton prior to the ginning process or the cleaning of the lint fiber in the gin stand. A later development by George Spencer was air conveyance of the lint fiber from the gin stand to lint cleaners, which consisted of herringbone grids for trapping dirt dislodged during air conveyance (*1*).[2]

In 1939, in light of previous lint-cleaning research and the potential development of a mechanical cotton harvester, the U.S. Cotton Ginning Research Laboratory initiated work on this phase of ginning. Initial efforts of the laboratory were to design a machine that incorporated both air-wash cleaning and mechanical scrubbing principles (*9*).

The result was a single saw-cylinder cleaner. Efforts were made to maintain simplicity while employing as many principles of cleaning as feasible. In this machine, the lint was pneumatically conveyed past a revolving screen cylinder and delivered to the saw-cylinder. The cleaning principles employed are centrifugal force, combing, gravity, and air-wash separation plus the cleaning action obtained by blowing small tufts of ginned lint past a revolving screen drum. A major portion of the cleaning is obtained from the scrubbing action created between the saw-cylinder and the triangular grid bars.

This machine was designed to clean the lint concurrently with ginning and became known as the "flow-through lint cleaner." It was installed and tested in a commercial gin plant during the 1948–49 ginning season. Tests indicated consistent and significant grade improvement on all types of cotton without injury to fiber or spinning qualities of the lint. However, the experiments brought out that lint cleaning is designed primarily for increasing the value of trashy or machine-harvested cotton. In 1951, U.S. Patent No. 2,569,501 was granted to Victor Stedronsky and C. Scott Shaw, employees of the U.S. Cotton Ginning Research Laboratory, for the development of this cleaner.

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[2] Italic numbers in parentheses refer to items in "Literature Cited," p. 16.

About the same time, E. H. Brooks was credited with the development of a controlled-batt lint cleaner (*2*), employing the same cleaning principles as the flow-through cleaner except that lint from the gin stand is formed into a batt on the condenser screen. The batt is fed through one or more compression rollers and between a closely fitted feed roll and feed plate onto the saw-cylinder. The spline feed roll and plate grip the batt of cotton so that a combing action takes place as the saw teeth seize the fibers.

The development of lint-cleaning machines was responsible in part for the overwhelming acceptance of the mechanical cotton harvester. Concurrently, the mechanical harvester and the lint cleaner became integral parts of the cotton harvesting and ginning system. In 1948, when about 2 percent of the cotton crop was harvested mechanically, only 30 of 7,000 operating cotton ginning systems had lint-cleaning equipment. In July 1959, the number of gin plants in the United States had decreased to 6,368, but 72 percent were using lint cleaners (*11*).

Since the early 1950's, the controlled-batt, saw-type cleaner has been widely used for cleaning Upland cottons. Lint-cleaner experiments have been conducted to determine the optimum settings for maximum dollar returns from each bale of seed cotton processed. Research efforts in the 1950's established data concerning the economics of lint cleaners when used under various operating conditions (*3, 6, 7*).

In 1964, Mangialardi and Griffin (*5*) showed that the controlled-batt, saw-cylinder cleaner produced significant improvement in grade classification. However, these grade improvements were accompanied by significant decreases in classer's staple length, 2.5-percent span length, and 50-percent span length and uniformity ratio, and by a highly significant increase in nep count.

A 2-year study (1966–67) by Mangialardi (*4*) showed that increasing the lint combing ratio by raising the saw-cylinder speed or by lowering the feed-roller speed significantly reduced the foreign-matter content of the lint and improved the classer's grade. However, the increase in combing ratio also shifted the fiber-length distribution toward the shorter fibers, gave shorter staple lengths and increased neps. The study also revealed that the efficiency of the saw-type cleaner for removing foreign matter from the lint was directly related to saw-cylinder speed.

In 1972, virtually all active gin plants in the United States were equipped with lint cleaning equipment. Actual figures indicate 3,686 of a total of 3,710 gin plants had lint cleaners—over 99 percent of the total. Gin plants having multiple stages of lint cleaning also increased; approximately 82 percent with lint cleaners had two or more stages of cleaning (*11*).

This increase in the use of lint-cleaning equipment stems directly from the increased mechanization of cotton harvesting. Mechanical harvesters increase the trash content of the cotton and alter the nature of the trash, which, in conjunction with the farmer's demand for increased gross returns, creates a greater demand for cleaning lint at the cotton gins. Lint cleaning reduces the trash content of the lint and tends to improve the grade of the cotton; therefore, it may increase the gross returns to the farmer.

PURPOSE AND SCOPE OF STUDY

Commercial lint cleaners, as developed by gin equipment manufacturers, vary in design and operating characteristics. Saw-cylinder diameters vary from 12 to 17 inches (*8*), and the recommended operating speed of both the saw-cylinder and the spline feed roll vary from one manufacturer to another. Lint cotton is thus subjected to a wide range of lint combing ratios.[3]

Because of differences in climate and length of growing season, various cotton varieties are predominant in different sections of the Cotton Belt. These varieties exhibit different fiber, trash, and seed properties. Processing characteristics of the seed cotton vary because of these properties.

In view of variations in both equipment and cotton, a 2-year study was made to investigate the effects of operating parameters on a variety of cotton predominantly grown in the Southeastern States.

Seed cotton employed for the study was the 'Coker 201' variety. All cotton was machine-harvested with experiments conducted at the U.S. Department of Agriculture, Agricultural Research Service, Southeastern Cotton Ginning

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[3] Combing ratio is defined as the ratio of the tip speed (ft/min) of the combing saw to the rim speed (ft/min) of the spline feed roll.

Research Laboratory, Clemson, S.C. All fiber tests were made by the Consumer and Marketing Service, Clemson, S.C. Samples were classed at the Consumer and Marketing Service Classing Office, Columbia, S.C.

OBJECTIVES

The lint-cleaner feed rates chosen for the feed-rate experiment were less than, equal to, and greater than, the manufacturer's recommended rate of 4 bales per hour. The specific objectives of the study were—

To determine the effects of the various lint feed rates on foreign-matter content of the ginned lint and on lint cleaner efficiency;

To determine the effects of lint feed rate on fiber quality and final bale values; and

To investigate the effect of lint feed rate on the amount of waste material removed by one stage of saw-cylinder cleaning.

The second experiment involved the testing of three saw-cylinder speeds at each of the three feed-roll speeds. These combinations of speeds produced a total of nine operating conditions. The speeds for both the saw-cylinder and feed roll were selected to be less than, equal to, and greater than, the manufacturer's recommended speed of operation. The specific objectives of this investigation were—

To determine the effects of saw-cylinder and feed-roll speed on foreign-matter removal and lint-cleaner efficiency;

To determine the effects of the various operating conditions on fiber quality and fiber-length distribution of the cleaned lint;

To determine the optimum lint-cleaner saw-cylinder and feed-roll settings for maximum lint-cleaner efficiency and bale value with minimum changes in staple length and fiber-length distribution; and

To determine the effects of saw-cylinder and feed-roll speed on the amount of waste material removed and to determine the composition of the waste material removed by the various operating conditions.

EXPERIMENTAL METHOD

Processing Sequence

The processing sequence and overhead cleaning machinery for both series of experiments were as follows:

1. Automatic feed control.
2. Tower drier 1.
3. 7-cylinder cleaner 1.
4. Stick machine.
5. Tower drier 2.
6. 7-cylinder cleaner 2.
7. Gin stand.
8. Lint cleaner 1 (experimental cleaner).
9. Lint cleaner 2.
10. Baling press.

Experimental Equipment

The lint cleaner used in the tests was a controlled-batt, saw-type cleaner. The diameters of the spline feed roll and the saw cylinder were 4-7/16 and 16 inches, respectively. The saw cylinder was 62½ inches long with eight grid bars for cleaning. The saw cylinder and feed roll were driven by separate power units to obtain the desired combination of speeds.

Sampling Schedule

The sampling schedule required samples for—

1. Seed cotton moisture and foreign-matter content before and after seed cotton cleaning.
2. Lint moisture after ginning, after the first stage of lint cleaning, and at the lint slide.
3. Lint foreign-matter content, color, grade, staple length and fiber-length distribution analyses before and after the first stage of lint cleaning and at the lint slide.
4. Lint-cleaner waste removed from the first stage of lint cleaning.
5. Foreign-matter content, color, and fiber-length distribution of the lint-cleaner waste material.

LINT-CLEANER FEED RATE STUDY

Experimental Design and Statistical Analyses

The experiment was performed as a randomized complete block design with three lint cleaner feed rates replicated six times. Each replication involved three bales of cotton—one for each lint-cleaner feed rate. Data were obtained from only the first stage of lint cleaning.

The degrees of freedom (*10*) were partitioned as follows for the analysis of variance:

Source	Degrees of freedom
Replication	5
Treatment	2
Error	10
Total	17

A covariance analysis was made on data of certain variables requiring similar measurements before and after lint cleaning. In such cases, the values of the dependent variable taken after lint cleaning were adjusted to take into account the differences in the values of the associated independent variable prior to lint cleaning. The data taken before lint cleaning were considered the covariates. For the covariance analysis, the degrees of freedom were distributed as follows:

Source	Degrees of freedom
Replication	5
Treatments	2
Covariate	1
Error	9
Total	17

The *F*-values resulting from the analyses of the data and the corresponding significance levels are summarized in appendix tables 19 and 20.

Experimental Procedure

The desired ginning rates for the experiment were 2.5, 4.0, and 5.5 bales per hour per gin stand with equivalent lint-cleaner feed rates of 20, 32, and 44 pounds per hour per inch of saw-cylinder length. Actual ginning rates for the experiment averaged 2.8, 4.5, and 5.3 bales per hour. These ginning rates produced lint-cleaner feed rates of 22.1, 35.9, and 42.2 pounds per hour per inch of saw-cylinder length. These feed rates produced batt weights of 0.035, 0.056, and 0.066 pound of lint per square foot of batt area. The seed cotton processing rate through the overhead cleaning operation averaged 5.9 bales per hour and was virtually constant throughout the experiment.

The lint cleaner was operated at the manufacturer's recommended speed. The 16-inch-diameter saw cylinder rotated at 890 r/min (3,728 ft/min saw-tip speed), and the corresponding spline feed roll rotated at 110 r/min (128 ft/min peripheral speed). This combination of tip speeds produced a combing ratio of 29.2:1.

Seed Cotton Data

Oven-dry moisture of seed-cotton samples from the wagon averaged 10.97 percent. After processing through the overhead cleaning machinery, the moisture content was reduced to an average of 9.63 percent at the feeder apron. Fractionation tests of seed cotton samples from the wagon showed an average foreign-matter content of 4.40 percent, as compared to 2.03 percent at the feeder apron. A statistical analysis of the seed-cotton data for both the moisture level and trash content at the feeder apron revealed no significant differences for treatments.[4] A summary of the data is shown in table 1.

Lint-Moisture Data

Lint samples were taken between the gin stand and lint cleaner for lint-moisture determinations. The moisture content of the ginned lint, as determined by the oven-drying method, averaged 5.65 percent for all test lots. The treatment averages ranged from a low of 5.59 percent to a high of 5.75 percent (table 2). Analysis revealed no significant difference for treatments.

Lint Foreign-Matter Content

The lint foreign-matter content as determined by the Shirley analyzer averaged 8.21 percent before lint cleaning and 3.43 percent after the first stage of lint cleaning. A summary of these data is shown in table 2.

The rate of ginning had a highly significant effect on the foreign-matter content of the ginned lint, which, before lint cleaning, increased progressively from an average of 7.26 to 9.05 percent by weight as the ginning rate increased from an average of 2.8 to 5.3 bales per hour (table 2). Significant differences in foreign-matter content after lint cleaning were also found; covariance analysis indicated that they were directly related to the significant differences present before lint cleaning and not attributable to the variation in lint-cleaner feed rates.

Lint-Cleaner Efficiency

Lint-cleaner efficiency (table 2) for the treatments ranged from an average low of 57.8 percent to an average high of 58.5 percent with an average for all treatments of 58.2 percent.[5]

Increasing the feed rate to the lint cleaner from 22.1 to 42.2 pounds per hour per inch of saw-cylinder length had no significant effect on cleaning efficiency. For lint-cleaner feed rates

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[4] Hereafter, a significant difference refers to significance at the 5% level, whereas a highly significant difference means significance at the 1% level.

[5] Lint-cleaner efficiency is the ratio of the foreign matter removed by lint cleaning to the foreign-matter content of the lint cotton entering the lint cleaner.

TABLE 1.—*Percentage of seed cotton moisture and foreign matter in lint-cleaner feed rate study*

Treatment and replication[1]	Moisture		Foreign matter	
	Wagon	Feeder apron	Wagon	Feeder apron
Treatment 1:				
1	10.55	10.35	3.73	2.04
2	6.88	6.79	4.26	1.22
3	11.35	9.77	3.74	1.88
4	9.74	8.20	4.77	1.79
5	13.81	11.51	6.02	2.56
6	13.18	9.85	4.63	2.14
Average	10.92	9.41	4.53	1.94
Treatment 2:				
1	11.03	9.62	4.15	2.16
2	7.45	7.23	3.57	.92
3	12.91	10.95	3.75	1.77
4	9.99	7.93	4.52	1.61
5	12.74	12.03	3.98	2.52
6	13.98	10.23	5.92	3.05
Average	11.35	9.66	4.32	2.01
Treatment 3:				
1	10.19	9.39	4.12	1.95
2	7.00	8.35	3.13	1.25
3	11.71	10.73	2.68	2.01
4	9.38	8.39	3.68	1.67
5	11.30	11.34	6.42	3.04
6	14.23	10.67	6.01	2.88
Average	10.64	9.81	4.34	2.13
Overall average	10.97	9.63	4.40	2.03

[1] Treatment:
1. Ginning rate=2.8 bales/hr; lint-cleaner feed rate=22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate=4.5 bales/hr; lint-cleaner feed rate=35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate=5.3 bales/hr; lint-cleaner feed rate=42.2 lb/hr/in. saw-cyl. length.

of 22.1, 35.9, and 42.2 pounds per hour per inch of saw-cylinder, the lint-cleaner efficiency averaged 58.4, 58.5, and 57.8 percent, respectively.

Classer's Index, Grade, and Staple Length

The one stage of experimental lint cleaning increased the average grade index from 81.76 to 91.22. The equivalent increase in grade designation was from Middling Tinged to Middling Light Gray. The average staple length decreased from 35.06 to 34.71 thirty-seconds of an inch. A summary of the data is shown in table 3.

Differences in grade index, grade designation, and staple length after lint cleaning were minor and were not significantly different for lint cleaner feed rates.

Fiber-Length Distribution

Data for upper quartile length, mean length, coefficient of variation, fibers longer than 1 inch, fibers ½ to 1 inch long, and fibers shorter than ½ inch are summarized in tables 4 and 5.

One stage of experimental lint cleaning decreased the upper quartile length from an average of 1.242 inches before lint cleaning to 1.232 inches after lint cleaning. The mean length decreased from an average of 1.019 inches to an average low of 1.000 inch. The coefficient of variation increased slightly after lint cleaning. A slight decrease in the percentage of fibers longer than 1 inch and a slight increase in percentage fibers ½ to 1 inch long and less than

TABLE 2.—*Percentage of fiber moisture and lint foreign matter before and after lint cleaning, and lint-cleaner efficiency in percent, in lint-cleaner feed rate study*

Treatment and replication[1]	Moisture at ginning	Foreign matter		Lint-cleaner efficiency
		Before	After	
Treatment 1:				
1	5.62	7.63	3.23	57.7
2	6.30	6.47	2.90	55.2
3	6.25	7.10	3.03	57.3
4	4.62	7.10	2.87	59.6
5	5.18	7.63	3.07	59.8
6	5.63	7.60	3.03	60.1
Average	5.60	7.26	3.02	58.4
Treatment 2:				
1	5.00	9.07	3.60	60.3
2	5.90	6.63	2.93	55.8
3	5.68	8.43	3.53	58.1
4	5.40	8.03	3.63	54.8
5	5.45	7.30	3.03	58.5
6	6.13	10.47	3.97	62.1
Average	5.59	8.32	3.45	58.5
Treatment 3:				
1	5.08	8.93	3.43	61.6
2	5.93	7.30	3.36	54.0
3	6.42	9.40	4.03	57.1
4	5.78	8.46	3.93	53.5
5	5.03	9.83	3.97	59.6
6	6.25	10.40	4.20	59.6
Average	5.75	9.05	3.82	57.8
Overall average	5.65	8.21	3.43	58.2

[1] Treatment:
1. Ginning rate=2.8 bales/hr; lint-cleaner feed rate=22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate=4.5 bales/hr; lint-cleaner feed rate=35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate=5.3 bales/hr; lint-cleaner feed rate=42.2 lb/hr/in. saw-cyl. length.

½ inch long were attributable to lint-cleaner feed rate. Lint feed rate had no significant effect on upper quartile length, coefficient of variation, or any of the fiber-length measurements.

Bale Weights

The one stage of experimental lint cleaning reduced the average bale weight from 561.0 to 527.6 pounds of lint per 1,500 pounds of seed cotton processed. A summary of these weights is shown in table 6.

Covariance analysis indicated that the lint-cleaner feed rate had a highly significant effect on bale weights after lint cleaning. Adjusting the treatment means of bale weights for the significant covariate (bale weight before lint cleaning), the adjusted bale weights after lint cleaning for lint feed rates of 22.1, 35.9 and 42.2 pounds per hour per inch of saw-cylinder were 529.7, 526.8, and 526.1 pounds, respectively. This decrease in bale weight for the highest lint feed rate is due to the amount of waste materials removed during lint cleaning (appendix table 15). The maximum rate of removal occurred at the highest lint-cleaner feed rate—42.2 pounds per hour per inch of saw-cylinder length.

Loan Values and Bale Values

The loan price had a base rate of 21 cents per pound for Middling grade, 1-inch staple length. The loan prices for this investigation were determined by the classer's grade and staple length.

The applicable loan prices were increased from an average of 18.15 to 21.72 cents per pound

TABLE 3.—*Classer's grade index, grade, and staple length for cotton before and after one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Grade index		Grade designation		Staple length (1/32-in.)[3]	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1	82.72	91.83	SLM sp.	Mid. Lt. gray	35.06	34.89
2	81.78	91.78	Mid. tinge	Mid. Lt. gray	35.06	34.56
3	80.78	90.06	SGO+	LM+	35.06	34.67
Average	81.76	91.22	Mid. tinge	Mid. Lt. gray	35.06	34.71

[1] Data are the average of 18 samples, 3 for each of 6 replications.

[2] Treatment:

1. Ginning rate=2.8 bales/hr; lint-cleaner feed rate=22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate=4.5 bales/hr; lint-cleaner feed rate=35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate=5.3 bales/hr; lint-cleaner feed rate=42.2 lb/hr/in. saw-cyl. length.

[3] Staple lengths are averages and do not reflect measurement accuracy.

TABLE 4.—*Upper quartile length, mean length, and coefficient of variation for cotton before and after one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Upper quartile length, in.		Mean length, in.		Coefficient of variation, %	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1	1.245	1.230	1.027	1.003	29.7	30.5
2	1.245	1.228	1.018	.998	30.8	31.3
3	1.235	1.237	1.013	.998	30.2	31.5
Average	1.242	1.232	1.019	1.000	30.2	31.1

[1] Data are the average of 6 samples, 1 for each of 6 replications.

[2] Treatment:

1. Ginning rate=2.8 bales/hr; lint-cleaner feed rate=22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate=4.5 bales/hr; lint-cleaner feed rate=35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate=5.3 bales/hr; lint-cleaner feed rate=42.2 lb/hr/in. saw-cyl. length.

TABLE 5.—*Percentage of fibers longer than 1 inch, ½ to 1 inch long, and shorter than ½ inch for cotton before and after one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Fibers longer than 1 inch		Fibers ½ to 1 inch long		Fibers shorter than ½ inch	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1	62.1	59.1	29.1	31.4	8.2	9.0
2	62.4	59.1	27.9	30.6	9.0	9.8
3	61.5	58.9	29.6	30.7	8.4	9.9
Average	62.0	59.0	28.9	30.9	8.5	9.6

[1] Data are the average of 6 samples, 1 for each of 6 replications.

[2] Treatment:

1. Ginning rate=2.8 bales/hr; lint-cleaner feed rate=22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate=4.5 bales/hr; lint-cleaner feed rate=35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate=5.3 bales/hr; lint-cleaner feed rate=42.2 lb/hr/in. saw-cyl. length.

TABLE 6.—*Bale weights, loan values, and bale values before and after one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Bale weight,[3] lb		CCC loan value, ¢/lb		Bale value	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1	557.4	526.5	18.51	22.17	$103.17	$116.73
2	562.1	527.8	18.05	21.76	101.46	114.85
3	563.6	528.4	17.88	21.24	100.77	112.23
Average	561.0	527.6	18.15	21.72	101.80	114.60

[1] Data are the average of 6 samples, 1 for each of 6 replications.

[2] Treatment:

1. Ginning rate = 2.8 bales/hr; lint-cleaner feed rate = 22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate = 4.5 bales/hr; lint-cleaner feed rate = 35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate = 5.3 bales/hr; lint-cleaner feed rate = 42.2 lb/hr/in. saw-cyl. length.

[3] Bale weights are based on 1,500 lb. of seed cotton.

by one stage of experimental lint cleaning (table 6). The corresponding bale values averaged from $101.80 before lint cleaning to $114.60 per bale after one stage of lint cleaning. The average increase was $12.80 per bale (1,500 pounds of seed cotton). After lint cleaning, the average bale value for the lowest lint-cleaner feed rate averaged $116.73 per bale while for the high feed rate they averaged $112.23 per bale. The differences in bale values, when attributed to lint-cleaner feed rates, were not statistically significant.

Lint-Cleaner Waste Material

The amount of waste material removed by the one stage of lint cleaning averaged 33.5 pounds per bale for this investigation. Lint-cleaner feed rates had significant effects on the amount of lint-cleaner waste removed. The amount of waste material removed increased from an average of 30.9 to 35.2 pounds per bale as the lint feed rate increased from an average of 22.1 to 42.2 pounds per hour per inch of saw-cylinder.

The foreign-matter content of the lint cleaner waste material, appendix table 16, averaged 74.8 percent, by weight. The composition of the lint-cleaner waste was not significantly affected by the various lint-cleaner feed rates.

Fiber-Length Distribution of Lint-Cleaner Waste

A summary of the fiber properties of the lint-cleaner waste material is shown in table 7. No significant differences in any of the fiber properties were attributable to lint-cleaner feed rates.

LINT-CLEANER SAW-CYLINDER AND FEED-ROLL SPEED STUDY

Experimental Design and Statistical Analyses

A randomized complete block design, consisting of three lint-cleaner saw-cylinder speeds and three feed-roll speeds arranged factorially and replicated three times, was used. The factorial arrangement of the three feed-roll speeds and the three saw-cylinder speeds produced nine treatment combinations for testing. A one-bale lot was processed for each treatment combination per replication.

Data obtained from the experiment were analyzed by use of an analysis of variance or an analysis of covariance (*10*). For data analyzed by the analyses of variance, the degrees of freedom were partitioned as follows:

Source	Degrees of freedom
Replication	2
Saw-cylinder speed	2
Feed-roll speed	2
Interaction	4
Error	16
Total	26

An analysis of covariance was made for data of certain variables requiring similar measurements before and after lint cleaning. In such cases, the measurement before lint cleaning was taken as the covariate. For the covariance analysis the degrees of freedom were partitioned as follows:

Source	Degrees of freedom
Replication	2
Saw-cylinder speed	2
Feed-roll speed	2
Interaction	4
Covariate	1
Error	15
Total	26

The *F*-values and significance levels obtained from the statistical analyses are shown in the appendix.

Experimental Procedure

The overhead processing rate and ginning rate were held constant for all test lots and averaged 4.1 bales per hour. This is equivalent to a lint feed rate of 32.4 pounds per hour per inch of saw-cylinder length.

The selected speeds for the saw-cylinder were 775, 890, and 1,010 r/min, which produced saw-tip speeds of 3,246, 3,728 and 4,230 ft/min, respectively.

The lint feed roll rotated at speeds of 80, 110, or 140 r/min. The corresponding peripheral speeds of the feed roll were 92.9, 127.8, and 162.6 ft/min. These feed-roll speeds resulted in batt weights of 0.070, 0.051, and 0.040 pound of lint per square foot of batt area. The combinations of feed-roll and saw-cylinder speeds produced nine lint combing ratios ranging from a low of 20.0:1 to a high of 45.5:1.

Seed Cotton Data

Moisture determinations and fractionation tests were made on seed cotton samples taken from the wagon and at the feeder apron. Average moisture was 10.27 percent at the wagon and was reduced to 8.52 percent at the feeder apron (table 8). Seed cotton trash content was 5.19 percent on the wagon and 2.34 percent at the feeder apron.

Lint-Moisture Data

Lint-moisture determinations were made on samples taken between the gin stand and the lint cleaner, and they indicated the moisture content averaged 4.26 percent (table 9). The moisture content of the lint after lint cleaning averaged 3.93 percent.

Lint moisture after cleaning was not significantly affected by either saw-cylinder or feed-roll speeds.

Lint Foreign-Matter Content

In Shirley analyzer tests, the lint foreign-matter content averaged 7.1 percent before lint cleaning and 3.1 percent after the first stage of saw-cylinder cleaning (table 9).

Increasing the saw-cylinder speed gave progressive and highly significant decreases in lint foreign-matter content after lint cleaning. In Shirley analyzer tests, foreign-matter content averaged 3.3, 3.2 and 2.9 percent, respectively, for saw-cylinder speeds of 775, 890, and 1,010 r/min.

Variations in feed-roll speed had no significant effect on the foreign-matter content of the cleaned lint. For feed-roll speeds of 80, 110, and 140 r/min, the foreign-matter content averaged 3.2, 3.0, and 3.1 percent, respectively.

Lint-Cleaner Efficiency

Lint-cleaner efficiency for the various treatment combinations varied from an average low

TABLE 7.—*Fiber-length distribution for waste material removed by one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Upper quartile length, in.	Mean length, in.	Coefficient of variation, %	Fibers longer than 1 inch, %	Fibers ½ to 1 inch long, %	Fibers shorter than ½ inch, %
1	1.217	0.940	37.3	53.0	31.1	15.4
2	1.200	.925	38.0	52.0	31.1	16.3
3	1.188	.905	39.0	48.4	33.5	17.6
Average	1.202	.923	38.1	51.1	31.9	16.4

[1] Data are the average of 6 samples, 1 for each of 6 replications.

[2] Treatment:
1. Ginning rate = 2.8 bales/hr; lint-cleaner feed rate = 22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate = 4.5 bales/hr; lint-cleaner feed rate = 35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate = 5.3 bales/hr; lint-cleaner feed rate = 42.2 lb/hr/in. saw-cyl. length.

TABLE 8.—*Percentage of seed cotton moisture and foreign matter in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Moisture level		Foreign matter	
	Wagon	Feeder	Wagon	Feeder
1a	10.51	8.44	5.76	2.41
1b	9.13	7.99	4.54	1.76
1c	9.80	7.65	5.81	2.25
Means	9.81	8.03	5.37	2.14
2a	11.07	8.94	5.46	2.84
2b	9.71	8.88	4.67	2.35
2c	11.19	9.39	5.28	2.46
Means	10.66	9.07	5.14	2.55
3a	10.08	8.17	5.00	2.17
3b	9.95	8.22	5.39	2.70
3c	10.98	9.01	4.82	2.10
Means	10.34	8.47	5.07	2.32
Overall averages	10.27	8.52	5.19	2.34
a[3]	10.55	8.52	5.41	2.47
b	9.60	8.36	4.87	2.27
c	10.66	8.68	5.30	2.27

[1] Data are the average of 9 samples, 3 for each of 3 replications.

[2] Treatment identification codes indicate the treatment combinations the samples received. Numerals indicate saw-cylinder speed—1 = 775 r/min; 2 = 890 r/min; and 3 = 1010 r/min. Letters indicate feed-roll speed—a = 140 r/min; b = 110 r/min; and c = 80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means for given feed-roll speed at all saw-cylinder speeds.

of 49.7 percent to an average high of 60.8 percent. The average for all treatment combinations and replications was 55.8 percent (table 9).

Saw-cylinder speed had a highly significant effect on lint-cleaner efficiency. Cleaner efficiency (table 9) progressively increased from an average low of 51.5 percent to an average high of 59.5 percent as saw-cylinder speed was increased from 775 to 1,010 r/min. Feed-roll speed had no significant effect on the efficiency of the lint cleaner. Treatment means showing the effect of saw-cylinder and feed-roll speeds are plotted in figure 1.

Classer's Index, Grade, and Staple Length

The one stage of experimental lint cleaning increased the average grade index from 80.98 to 91.69. The equivalent increase in grade designation was from Low Middling-Light Spot to Strict Low Middling. The average staple length remained virtually constant. Table 10 summarizes these data.

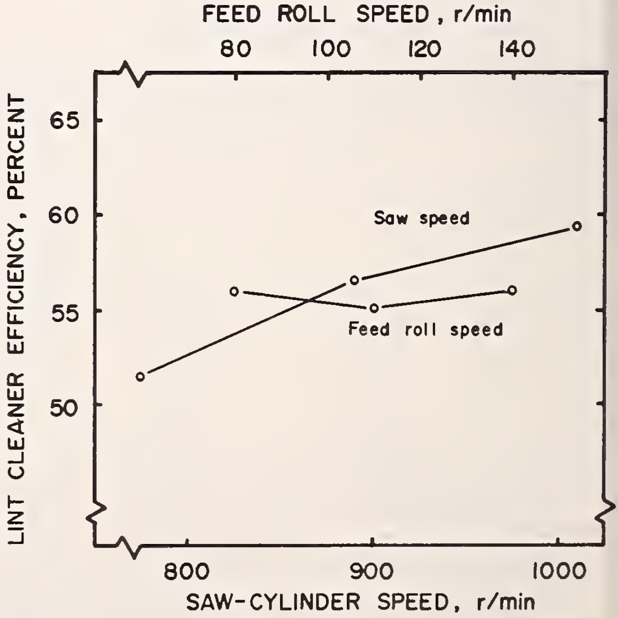

FIGURE 1.—Effect of saw-cylinder and feed-roll speeds on lint-cleaner efficiency.

TABLE 9.—*Percentage of lint moisture and foreign matter before and after lint cleaning, and lint-cleaner efficiency in percent, in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Lint-moisture		Lint foreign matter		Lint cleaner efficiency
	Before cleaning	After cleaning	Before cleaning	After cleaning	
1a	4.33	4.13	6.8	3.3	51.4
1b	4.08	3.74	6.3	3.2	49.7
1c	3.98	3.63	7.2	3.4	53.3
Means	4.13	3.83	6.8	3.3	51.5
2a	4.81	4.32	7.9	3.3	56.8
2b	4.52	4.33	6.6	2.9	55.5
2c	5.55	4.66	7.9	3.3	57.5
Means	4.96	4.44	7.5	3.2	56.6
3a	3.37	3.37	7.1	2.8	60.8
3b	3.92	3.69	7.3	2.9	60.4
3c	3.78	3.48	7.0	3.0	57.2
Means	3.69	3.51	7.1	2.9	59.5
Overall averages	4.26	3.93	7.1	3.1	55.8
a[3]	4.17	3.94	7.3	3.1	56.3
b	4.17	3.92	6.7	3.0	55.2
c	4.13	3.92	7.3	3.2	56.0

[1] Data are the average of 9 samples, 3 for each of 3 replications.

[2] Treatment identification codes indicate the treatment combination the samples received. Numerals indicate saw-cylinder speed—1 = 775 r/min; 2 = 890 r/min; and 3 = 1010 r/min. Letters indicate feed-roll speed—a = 140 r/min; b = 110 r/min; and c = 80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means for given feed-roll speed at all saw-cylinder speeds.

Statistical analysis indicated no significant differences in grade index after lint cleaning due to either saw-cylinder or feed-roll speeds.

Staple lengths after lint cleaning decreased progressively from an average of 34.56 to 34.22 thirty-seconds of an inch as saw-cylinder speed was increased from 775 to 1,010 r/min. Although these differences are statistically significant and are attributed to the increased saw-cylinder speeds, they are minor and have no practical application. Feed-roll speed had no significant effect on staple length.

Fiber-Length Distribution

Increasing the saw-cylinder and feed-roll speed had no significant effects on any of the fiber properties summarized in tables 11 and 12. Differences in fiber properties attributable to saw-cylinder speeds, feed-roll speeds or the interaction of saw-speed and feed-roll speed were minor and not statistically significant.

Averages for upper quartile length remained unchanged at 1.20 inches. Averages for fiber mean length after cleaning decreased from 0.97 to 0.96 inch, and the coefficient of length variation showed a slight increase from 31.3 to 32.1 percent. Percentages of fibers classified as longer than 1 inch decreased slightly while fibers classified as ½ to 1 inch and less than ½ inch in length increased.

Bale Weights

One stage of experimental lint cleaning decreased the average bale weight from 575.9 to 542.8 pounds of lint per 1,500 pounds of seed cotton processed (table 13).

A covariance analysis indicated that bale weight before lint cleaning (covariate) had a significant effect on bale weight after lint cleaning. After adjustment for the significant covariate, saw-cylinder speed significantly affected bale weight after lint cleaning; the bale weights for saw speeds of 775, 890 and 1,010 r/min were 546.8, 541.0 and 540.8, respectively.

TABLE 10.—*Classer's grade index, grade designation, and staple length before and after one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Grade index		Grade designation		Staple length, 1/32 in.	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1a	83.22	90.78	LM+	SLM	34.22	34.67
1b	81.56	91.33	LM Lt. Sp.	SLM	34.11	34.45
1c	80.00	91.22	LM Lt. Sp.	SLM	34.11	34.56
Means	81.59	91.11	. . .	. . .	34.15	34.56
2a	82.00	91.33	LM	SLM	34.33	34.55
2b	80.00	91.78	LM Lt. Sp.	SLM	34.33	34.00
2c	80.00	91.78	LM Lt. Sp.	SLM	34.56	34.22
Means	80.67	91.63	. . .	. . .	34.41	34.26
3a	80.00	92.33	LM Lt. Sp.	SLM	34.34	34.00
3b	81.00	92.89	LM Lt. Sp.	SLM	34.00	34.22
3c	81.00	91.78	LM Lt. Sp.	SLM	34.33	34.44
Means	80.67	92.33		. . .	34.22	34.22
Overall averages	80.98	91.69	LM Lt. Sp.	SLM	34.26	34.34
a[3]	81.74	91.48	LM	SLM	34.30	34.41
b	80.85	92.00	LM Lt. Sp.	SLM	34.15	34.22
c	80.33	91.59	LM Lt. Sp.	SLM	34.33	34.41

[1] Data are the average of 9 samples, 3 for each of 3 replications.

[2] Treatment identification codes indicate the treatment combination the samples received. Numerals indicate saw-cylinder speed—1=775 r/min; 2=890 r/min; and 3=1010 r/min. Letters indicate feed-roll speed—a=140 r/min; b=110 r/min; and c=80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means of given feed-roll speed at all saw-cylinder speeds.

TABLE 11.—*Upper quartile length, mean length, and coefficient of variation for cotton before and after one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Upper quartile length, in.		Mean length, in.		Coefficient of variation, %	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1a	1.20	1.19	0.97	0.97	30.7	32.0
1b	1.20	1.21	.97	.99	31.0	30.7
1c	1.20	1.19	.97	.96	31.3	32.0
Means	1.20	1.20	.97	.97	31.0	31.6
2a	1.20	1.20	.98	.96	31.7	31.7
2b	1.20	1.20	.98	.97	30.7	32.0
2c	1.21	1.20	.99	.95	30.3	33.7
Means	1.20	1.20	.98	.96	30.9	32.5

TABLE 11.—*Upper quartile length, mean length, and coefficient of variation for cotton before and after one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]—Continued

Treatment[2]	Upper quartile length, in.		Mean length, in.		Coefficient of variation, %	
	Before Before	After cleaning	cleaning cleaning	After cleaning	Before cleaning	After cleaning
3a	1.20	1.20	.97	.97	31.7	31.7
3b	1.20	1.20	.96	.95	32.3	32.7
3c	1.20	1.19	.97	.95	31.7	32.7
Means	1.20	1.20	.97	.96	31.9	32.4
Overall averages	1.20	1.20	.97	.96	31.3	32.1
a[3]	1.20	1.20	.97	.97	31.4	31.8
b	1.20	1.20	.97	.97	31.3	31.8
c	1.20	1.19	.98	.95	31.1	32.8

[1] Data are the average of 3 samples, 1 for each of 3 replications.

[2] Treatment identification codes indicate the treatment combinations the samples received. Numerals indicate saw-cylinder speed—1=775 r/min; 2=890 r/min; and 3=1010 r/min. Letters indicate feed-roll speed—a=140 r/min; b=110 r/min; and c=80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means of given feed-roll speeds at all saw-cylinder speeds.

TABLE 12.—*Percentage of fibers longer than 1 inch, ½ to 1 inch long, and shorter than ½ inch for lint before and after one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Fibers longer than 1 inch		Fibers ½ to 1 inch long		Fibers shorter than ½ inch	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1a	55.7	54.0	34.4	35.2	9.4	10.2
1b	54.1	55.9	35.9	34.0	9.5	9.5
1c	53.9	53.9	35.5	35.5	10.1	10.1
Means	54.6	54.6	35.3	34.9	9.7	9.9
2a	54.1	51.9	35.5	37.7	9.8	9.9
2b	57.5	54.0	32.2	35.0	9.7	10.4
2c	57.4	51.7	33.0	36.0	9.1	11.7
Means	56.3	52.5	33.6	36.2	9.5	10.7
3a	55.1	54.4	34.5	35.0	9.9	10.1
3b	53.4	52.2	35.6	35.9	10.6	11.3
3c	55.5	51.1	34.1	37.3	9.8	10.9
Means	54.7	52.6	34.7	36.1	10.1	10.8
Overall average	55.2	53.2	34.5	35.7	9.8	10.4
a[3]	55.0	53.4	34.8	36.0	9.7	10.1
b	55.0	54.0	34.6	35.0	9.9	10.4
c	55.6	52.2	34.2	36.3	9.8	10.9

[1] Data are the average of 3 samples, 1 for each of 3 replications.

[2] Treatment identification codes indicate the treatment combinations the samples received. Numerals indicate saw-cylinder speed—1=775 r/min; 2=890 r/min; and 3=1010 r/min. Letters indicate feed-roll speed—a=140 r/min; b=110 r/min; and c=80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means of given feed-roll speeds at all saw-cylinder speeds.

TABLE 13.—*Bale weights, CCC loan values, and bale values before and after one stage of cleaning, in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Bale weight, lb		CCC loan value, ¢/lb		Bale value	
	Before cleaning	After cleaning	Before cleaning	After cleaning	Before cleaning	After cleaning
1a	575.2	544.0	18.33	20.56	$105.47	$112.05
1b	583.5	556.6	17.33	20.71	103.49	115.26
1c	575.0	545.7	17.22	20.51	99.02	111.92
Means	577.9	549.1	17.63	20.59	102.66	113.08
2a	572.5	536.6	17.78	20.76	101.83	111.61
2b	579.6	545.2	17.26	20.60	100.01	112.41
2c	574.7	539.9	17.28	20.68	99.28	111.94
Means	575.6	540.6	17.44	20.68	100.37	111.99
3a	576.9	541.8	17.23	20.93	99.38	113.48
3b	571.7	536.7	17.49	21.16	100.00	113.69
3c	573.7	537.9	17.52	20.73	100.53	111.49
Means	574.1	538.8	17.41	20.94	99.97	112.89
Overall average	575.9	542.8	17.49	20.74	101.00	112.65
a[3]	574.9	541.1	17.78	20.75	102.23	112.38
b	578.3	546.2	17.36	20.82	101.17	113.79
c	574.5	541.2	17.34	20.64	99.61	111.78

[1] Data are the average of 3 samples, 1 for each of 3 replications.

[2] Treatment identification codes indicate the treatment combinations the samples received. Numerals indicate saw-cylinder speed—1=775 r/min; 2=890 r/min; and 3=1010 r/min. Letters indicate feed-roll speed—a=140 r/min; b=110 r/min; and c=80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means of given feed-roll speeds at all saw-cylinder speeds.

The adjusted bale weights attributed to saw speed indicate that the decrease in bale weights was less for each increase in saw-cylinder speed. Differences in bale weights due to feed-roll speeds were minor and nonsignificant.

Loan Values and Bale Values

Loan values increased from an average of 17.49 to 20.74 cents per pound. The maximum increase was 3.70 cents per pound and resulted from the treatment combination created by a saw-cylinder speed of 1,010 r/min in combination with a feed-roll speed of 140 r/min.

Average bale values after lint cleaning for the various treatment combinations varied from a low of $111.49 to a high of $115.26 per bale (table 13). Because of the significant variation in bale values before lint cleaning, an adjustment was required to bale values after lint cleaning. However, differences in bale value after lint cleaning attributable to saw-cylinder and feed-roll speed were found to be minor and not statistically significant. The adjusted maximum bale value was $115.43 and was produced by the saw-cylinder speed of 1,010 r/min combined with a feed-roll speed of 140 r/min.

Lint-Cleaner Waste Material

Increases in saw-cylinder speeds significantly increased the amount of waste material removed. As saw-cylinder speed increased from 775 to 1,010 r/min, the amount of waste removed increased from an average low of 28.94 to an average high of 35.36 pounds per bale (1,500 pounds seed cotton). The treatment means of waste removed for each saw-cylinder speed indicate that the amount of waste material removed during lint cleaning increased at a decreasing rate as saw-cylinder speed increased. Differences in waste material removed due to feed-roll speed did not prove significant.

Foreign-Matter Content of Lint-Cleaner Waste

A significant relationship existed between saw-cylinder speed and foreign-matter content of the lint-cleaner waste. As saw-cylinder speed increased from 775 to 1,010 r/min, the foreign-matter content of the waste material, as determined by the Shirley analyzer test, decreased from an average high of 73.52 to an average low of 68.14 percent. The lint content of the waste material increased significantly as saw-cylinder speed increased. A plot of these relationships is shown in figure 2. Feed-roll speed was not a significant factor.

Fiber-Length Distribution of Lint-Cleaner Waste

Feed-roll speed significantly affected the upper quartile length, fibers longer than 1 inch and fibers ½ to 1 inch long in the lint cleaner waste. As feed-roll speed increased from 80 to 140 r/min, significant increases were recorded for upper quartile length and fibers longer than 1 inch. Fibers in the ½- to 1-inch category decreased with increased feed-roll speeds. Saw-cylinder speed had no significant effect on any of the measured variables. The data are summarized in table 14.

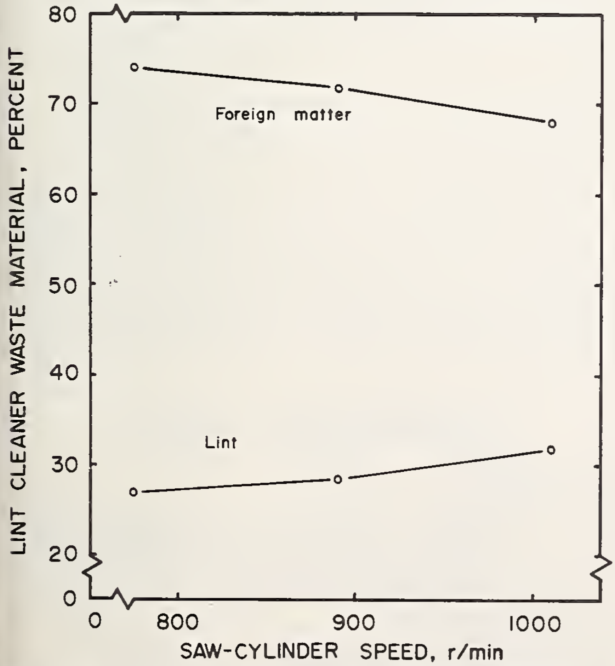

Figure 2.—Effect of saw-cylinder speed on percent of lint and foreign matter in lint-cleaner waste.

CONCLUSIONS

Significant findings in the lint-cleaner feed rate study and the saw-cylinder and feed-roll speed study are summarized below.

Lint-Cleaner Feed Rate Test

1. Increased rates of ginning significantly increased the foreign-matter content of the ginned lint. This condition carried through the lint-cleaner treatments and was reflected in the lint after cleaning. However, the highly significant differences in foreign-matter content after lint cleaning were not attributable to lint-cleaner feed rate. The level of the foreign-matter content before lint cleaning directly affected the level after lint cleaning.
2. Increased feed rates to the lint cleaner had no significant effect on lint-cleaner efficiency. Lint-cleaner efficiency for all lint feed rates averaged 58.2 percent.
3. Lint feed rate had no significant effect on any of the fiber-length measurements for either cleaned lint or the waste material removed by lint cleaning. Fiber-length measurements were virtually the same for all lint feed rates.
4. The quantity of waste material removed by the one stage of experimental lint cleaning increased significantly as lint feed rate increased. The increased quantity of waste material removed at the increased lint feed rates significantly reduced the bale weights after lint cleaning. Lint-cleaner feed rate had only minor and nonsignificant influence on foreign-matter content of the lint-cleaner waste material.
5. Differences in bale values attributable to lint feed rate were minor and nonsignificant.

Saw-Cylinder and Feed-Roll Speed Tests

1. Foreign-matter content of the lint after lint cleaning decreased as saw-cylinder speed increased from 775 to 1,010 r/min. The effects of feed-roll speed were minor and nonsignificant.
2. Increased saw-cylinder speeds significantly increased lint-cleaner efficiency, and as a result, increased the waste material removed. This, in turn, caused significant decreases in bale weights after lint cleaning at the increased saw-cylinder speeds. Differences in lint-cleaner efficiency due to feed-roll speed were minor and nonsignificant.
3. Classer's staple length measurements decreased significantly with increased saw-cylinder speeds. However, none of the measured fiber-length variables were significantly affect-

TABLE 14.—*Fiber-length distribution of waste material removed by one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Upper quartile length, in.	Mean length, in.	Coefficient of variation, %	Fibers longer than 1 inch, %	Fibers ½ to 1 inch, %	Fibers shorter than ½ inch, %
1a	1.14	0.87	38.7	40.6	40.8	18.1
1b	1.13	.87	38.3	40.9	41.1	17.6
1c	1.08	.81	40.3	33.4	45.8	20.1
Means	1.12	.85	39.1	38.3	42.6	18.6
2a	1.12	.84	40.7	39.7	38.2	21.6
2b	1.07	.80	41.0	32.7	44.0	22.9
2c	1.12	.86	38.7	40.7	39.4	19.2
Means	1.10	.83	40.1	37.7	40.5	21.2
3a	1.17	.91	37.0	49.6	33.8	16.1
3b	1.09	.80	41.6	32.9	43.9	22.6
3c	1.09	.80	41.3	34.2	42.4	23.0
Means	1.12	.84	40.0	38.9	40.0	20.6
Overall average	1.11	.84	39.7	38.3	41.0	20.1
a[3]	1.14	.87	38.8	43.3	37.6	18.6
b	1.10	.82	40.3	35.5	43.0	21.0
c	1.10	.82	40.1	36.1	42.5	20.8

[1] Data are the average of 3 samples, 1 for each of 3 replications.

[2] Treatment identification code indicates the treatment combination the sample received. Numerals indicate saw-cylinder speed—1 = 775 r/min; 2 = 890 r/min; and 3 = 1010 r/min. Letters indicate feed-roll speed—a = 140 r/min; b = 110 r/min; and c = 80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Means of given feed-roll speeds at all saw-cylinder speeds.

ed by either saw-cylinder or feed-roll speeds. The data indicated no significant shift of the fiber-length distribution toward the shorter fibers.

4. The saw-cylinder speed of 1,010 r/min in combination with a feed-roll speed of 140 r/min yielded the maximum lint-cleaner efficiency, the maximum increase in grade index and loan value, and the maximum bale value. This combination of speeds decreased the staple length and percentage of fibers longer than 1 inch; however, the upper quartile length, mean length and coefficient of variation of the cleaned lint remained unchanged. Both the amount of waste material removed per bale and the percentage of lint in the waste material increased.

5. Increased saw-cylinder speeds significantly increased the amount of waste material removed and also increased the lint content of the waste material. Feed-roll speed did not significantly affect either the waste material removed or the composition of the waste material.

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APPENDIX.—TABLES

TABLE 15.—*Lint-cleaner waste removed by one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Waste removed by replication, lb						Average
	1	2	3	4	5	6	all reps., lb
1	32.2	24.8	29.8	31.6	33.2	34.0	30.9
2	35.8	26.3	34.0	34.5	35.6	39.7	34.3
3	33.9	27.3	36.6	34.4	39.8	39.3	35.2
Average	34.0	26.1	33.5	33.5	36.2	37.7	33.5

[1] Data shown for each treatment are based on 1,500 lb of seed cotton.

[2] Treatment:
1. Ginning rate = 2.8 bales/hr; lint cleaner feed rate = 22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate = 4.5 bales/hr; lint cleaner feed rate = 35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate = 5.3 bales/hr; lint-cleaner feed rate = 42.2 lb/hr/in. saw-cyl. length.

TABLE 16.—*Percent foreign matter of lint-cleaner waste from one stage of cleaning in lint-cleaner feed rate study*[1]

Treatment[2]	Replication						Average
	1	2	3	4	5	6	all reps.
1	72.67	74.05	74.32	71.80	75.07	75.15	73.84
2	75.68	73.54	77.37	74.65	74.78	77.97	75.66
3	74.29	74.48	74.94	71.61	77.74	76.36	74.90
Average	74.21	74.02	75.54	72.69	75.86	76.49	74.80

[1] Data for each replication and treatment are an average of 3 Shirley analyzer tests.

[2] Treatment:
1. Ginning rate = 2.8 bales/hr; lint cleaner feed rate = 22.1 lb/hr/in. saw-cyl. length.
2. Ginning rate = 4.5 bales/hr; lint cleaner feed rate = 35.9 lb/hr/in. saw-cyl. length.
3. Ginning rate = 5.3 bales/hr; lint-cleaner feed rate = 42.2 lb/hr/in. saw-cyl. length.

TABLE 17.—*Lint-cleaner waste removed by one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Waste removed, lb			
	Replication 1	Replication 2	Replication 3	Mean[3]
1a	29.61	29.30	32.17	30.36
1b	25.42	26.80	29.09	27.10
1c	27.20	28.24	32.61	29.35
Means	27.41	28.11	31.29	28.94
2a	29.52	39.63	38.54	35.90
2b	29.62	36.13	36.78	34.17
2c	30.38	38.38	35.43	34.73
Means	29.84	38.05	36.91	34.93
3a	32.65	33.22	39.93	35.27
3b	30.47	37.89	36.57	34.98
3c	33.74	36.50	37.14	35.79
Means	32.29	35.87	37.88	35.35
Overall average	29.84	34.01	35.36	33.07
a[4]	30.59	34.05	36.88	33.84
b	28.50	33.61	34.14	32.08
c	30.44	34.37	35.06	33.29

[1] Average of 3 samples.

[2] Treatment identification codes indicate the treatment combinations the samples received. Numerals indicate saw-cylinder speed—1=775 r/min; 2=890 r/min; and 3=1010 r/min. Letters indicate feed-roll speed—a=140 r/min; b=110 r/min; and c=80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Average of 9 samples.

[4] Means of given feed-roll speeds for all saw-cylinder speeds.

TABLE 18.—*Percentage of foreign matter and lint in lint-cleaner waste material from one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]

Treatment[2]	Replication 1		Replication 2		Replication 3		Mean[3]	
	Foreign matter	Lint	Foreign matter	Lint	Foreign matter	Lint	Foreign matter	Lint
1a	69.42	30.58	73.86	26.14	75.95	24.05	73.08	26.92
1b	70.50	29.50	74.17	25.83	76.28	23.72	73.65	26.35
1c	70.83	29.17	73.83	26.17	76.87	23.13	73.84	26.16
Means	70.25	29.75	73.95	26.05	76.37	23.63	73.52	26.48
2a	65.94	34.06	76.14	23.86	73.40	26.60	71.83	28.17
2b	66.80	33.20	76.03	23.97	74.59	25.41	72.47	27.53
2c	68.54	31.46	73.21	26.79	71.45	28.55	71.07	28.93
Means	67.09	32.91	75.13	24.87	73.15	26.85	71.79	28.21

TABLE 18.—*Percentage of foreign matter and lint in lint-cleaner waste material from one stage of cleaning in lint-cleaner saw-cylinder and feed-roll speed study*[1]—Continued

Treatment[2]	Replication 1		Replication 2		Replication 3		Mean[3]	
	Foreign matter	Lint	Foreign matter	Lint	Foreign matter	Lint	Foreign matter	Lint
3a	65.97	34.03	67.55	32.45	69.77	30.23	67.76	32.24
3b	63.87	36.13	71.41	28.59	71.81	28.19	69.03	30.97
3c	65.69	34.31	68.72	31.28	68.51	31.41	67.64	32.36
Means	65.18	34.82	69.23	30.77	70.03	29.97	68.14	31.86
Overall average	67.51	32.49	72.77	27.23	73.18	26.82	71.15	28.85
a[4]	67.11	32.89	72.52	27.48	73.04	26.96	70.88	29.12
b	67.05	32.95	73.87	26.13	74.23	25.77	71.72	28.28
c	68.35	31.65	71.92	28.08	72.28	27.68	70.85	29.15

[1] Average of 3 Shirley analyzer tests.

[2] Treatment identification codes indicate the treatment combinations the samples received. Numerals indicate saw-cylinder speed—1=775 r/min; 2=890 r/min; and 3=1010 r/min. Letters indicate feed-roll speed—a=140 r/min; b=110 r/min; and c=80 r/min. Thus, sample 2b was processed with the saw-cylinder running at 890 r/min and the feed roll at 110 r/min.

[3] Average of 9 samples.

[4] Means of given feed-roll speeds for all saw-cylinder speeds.

TABLE 19.—*Statistical analyses (RCB) of lint-cleaner waste material in lint-cleaner feed rate study*

Item	F-values obtained and significance levels, analysis of variance[1] [2]	
	Replications	Lint feed rates
Waste weight	23.77 **	15.32 **
Waste foreign-matter content	3.92 *	3.29 ns
Upper quartile length	1.81 ns	1.67 ns
Mean length	2.01 ns	1.03 ns
Coefficient of variation	1.42 ns	.37 ns
Fiber longer than 1 inch	2.32 ns	1.64 ns
Fiber ½ to 1 inch long	1.47 ns	2.03 ns
Fiber less than ½ inch long	1.83 ns	.70 ns

[1] * = significant at 5% level; ** = significant at 1% level; ns = not significant at 5 % level.

[2] F-values required in analysis of variance for significance at 5% level are, for replication, 3.33, and for lint feed rate, 4.10 significance at the 1% level requires, for replication, 5.64, and for lint feed rate, 7.56.

TABLE 20.—*Statistical analyses (RCB) of fiber properties of processed lint in lint-cleaner feed rate study*

Item	*F*-values obtained and significance levels[1]				
	Analysis of variance[2]		Analysis of covariance[3]		
	Replications	Lint feed rate	Replications	Lint feed rate	Covariate
Ginned lint moisture	3.90 *	0.30 ns	. . .	. . .	. . .
Foreign-matter content, before lint cleaning	5.03 *	10.64 **	. . .	. . .	. . .
Foreign-matter content, after lint cleaning	2.04 ns	13.34 **	1.25 ns	0.99 ns	21.26 **
Lint cleaner efficiency	4.54 *	.57 ns	. . .	. . .	. . .
Grade index	6.81 **	1.00 ns	6.18 *	.90 ns	.06 ns
Staple length	2.52 ns	1.15 ns	2.30 ns	1.04 ns	.10 ns
Upper quartile length	2.00 ns	.50 ns	2.34 ns	.69 ns	2.97 ns
Mean length	2.50 ns	.00 ns	2.70 ns	.16 ns	1.97 ns
Coefficient of length variation	2.61 ns	1.62 ns	2.78 ns	1.74 ns	1.65 ns
Fiber longer than 1 inch	1.58 ns	.01 ns	1.67 ns	.01 ns	1.55 ns
Fiber ½ to 1 inch	.97 ns	.25 ns	1.01 ns	.30 ns	1.48 ns
Fiber less than ½ inch	2.62 ns	1.50 ns	3.11 ns	1.78 ns	2.87 ns
Bale weight	25.01 **	.23 ns	13.79 **	8.68 **	141.71 **
Bale value	16.91 **	2.04 ns	16.04 **	1.98 ns	.48 ns

[1] * = significant at 5% level; ** = significant at 1% level; ns = not significant at 5% level.

[2] *F*-values required in analysis of variance for significance at 5% level are for replication 3.33 and for lint feed rate 4.10; significance at the 1% level requires, for replication, 5.64 and for lint free rate 7.56.

[3] *F*-values required in analysis of covariance for significance at the 5% level are, for replication 3.48, for lint feed rate 4.26, and for covariate 5.12, significance at the 1% level requires, for replication 6.06, for lint feed rate 8.02, and for covariate 10.56.

TABLE 21.—*Statistical analyses (RCB) of fiber properties of processed lint in lint-cleaner saw-cylinder and feed-roll speed study*

Item	*F*-values obtained and significance levels[1]						
	Analysis of variance[2]			Analysis of covariance[3]			
	Saw-cylinder speed	Feed-roll speed	Interaction	Saw-cylinder speed	Feed-roll speed	Interaction	Covariate
Lint-moisture, after lint cleaning	4.34 *	0.00 ns	0.43 ns	0.47 ns	1.15 ns	0.50 ns	30.20 **
Lint foreign-matter, after lint cleaning	4.28 *	1.32 ns	.56 ns	8.36 **	.14 ns	.34 ns	8.89 **
Lint cleaner efficiency	12.03 **	.27 ns	.85 ns	. . .	. . .	. . .	. . .
Grade index	.97 ns	.19 ns	.10 ns	.94 ns	.18 ns	.10 ns	.42 ns
Staple length	4.70 *	1.56 ns	2.44 ns	4.41 *	1.46 ns	2.29 ns	.00 ns
Upper quartile length	.18 ns	.98 ns	.94 ns	.18 ns	.97 ns	.93 ns	.91 ns
Mean length	1.78 ns	2.11 ns	1.10 ns	1.83 ns	2.16 ns	1.13 ns	1.41 ns
Coefficient of length variation	.15 ns	1.07 ns	.88 ns	.15 ns	1.05 ns	.86 ns	.77 ns
Fibers longer than 1 inch	1.57 ns	.95 ns	.61 ns	1.71 ns	1.03 ns	.66 ns	2.43 ns
Fibers ½ to 1 inch	.76 ns	.66 ns	.60 ns	.77 ns	.68 ns	.60 ns	1.20 ns
Fibers less than ½ inch	1.24 ns	1.08 ns	.92 ns	1.17 ns	1.02 ns	.86 ns	.12 ns
Bale weight	.82 ns	.24 ns	.20 ns	50.19 **	2.10 ns	.57 ns	2502.84 **
Bale value	.06 ns	.17 ns	.06 ns	.71 ns	.73 ns	.78 ns	17.97 **

[1] * = significant at the 5% level; ** = significant at the 1% level; ns = not significant at the 5% level.

[2] Significance at the 5% level, requires *F*-values for saw-cylinder speed, 3.63; for feed-roll speed, 3.63; for interaction, 3.01; and for covariate, 4.49. Significance at the 1% level requires, for saw-cylinder speed, 6.23; for feed-roll speed, 6.23, for interaction, 4.77, and for covariate, 8.53.

[3] Significance at the 5% level requires *F*-values for saw-cylinder speed, 3.68; for feed-roll speed, 3.68, for interaction, 3.06; and for covariate, 4.54. Significance at the 1% level requires, for saw-cylinder speed, 6.36; for feed-roll speed,6.36; for interaction, 4.89; and for covariate, 8.68.

TABLE 22.—*Statistical analyses (RCB) of lint-cleaner waste material in lint-cleaner saw-cylinder and feed-roll speed study*

Item	F-values obtained and significance levels[1]		
	Saw-cylinder speed[2]	Feed-roll speed[2]	Interaction[2]
Waste weight	24.40 **	1.49 ns	0.42 ns
Waste foreign-matter content	23.28 **	.74 ns	.27 ns
Upper quartile length	.15 ns	3.66 *	1.74 ns
Mean length	.22 ns	3.07 ns	2.15 ns
Coefficient of variation	.26 ns	.61 ns	1.06 ns
Fibers longer than 1 inch	.07 ns	4.00 *	2.38 ns
Fiber ½ to 1 inch long	2.10 ns	10.14 **	3.85 *
Fibers less than ½ inch long	.84 ns	.79 ns	1.09 ns

[1] * = significant at 5% level; ** = significant at 1% level; ns = not significant at the 5% level.

[2] Significance at the 5% level requires F-values for saw-cylinder speed, 3.63, for feed-roll speed, 3.63, and for interaction, 3.01. Significance at the 1% level requires, for saw-cylinder speed, 6.23, for feed-roll speed, 6.23 and for interaction, 4.77.